Differences in warhead measures for this option compared with the Administration baseline tend to be modest throughout the 1990s, and are similar to the effects shown in Table 8 for the year 2000. However, as with the other options, there may be differences in less quantifiable measures of capability. Beyond the year 2000, differences resulting from this option would rapidly disappear as delayed systems become fully deployed.

Savings

Excluding savings from delaying the ATB, total five-year investment savings under this option would be $17.9 billion (see Table 7). Over the next two years alone, savings less those for the ATB would total $4.1 billion. Although this study cannot determine the savings from delaying the ATB because estimates are not available publicly, savings are likely to be substantial. The ATB is a $57 billion program that is probably approaching a period of heavy expenditure.

Even without savings from the ATB, these reductions could substantially alter the pace of strategic investment funding. If, for example, the Administration's plans result in 5 percent annual real growth over the next five years, this option would cut total costs by about 8 percent at a minimum, and leave growth averaging at most about 3 percent a year. Actual growth would be significantly lower because of savings from delaying the ATB.

The Congressional Budget Office cannot accurately determine the long-run effects of this option on investment costs, but there is a clear risk that they will increase. For example, delays would probably increase some development costs because contractors would keep their development teams together but could not proceed at full pace. On the other hand, delay could hold down some costs. General Skantze, recent head of the command that oversees development of all Air Force weapons, argues that the high level of concurrency (that is, overlapping development and production) in the B-1B program was a factor in the problems that the aircraft is now experiencing. Delays under this option would minimize concurrency.

This option should reduce near-term operating costs by modest amounts because of delayed deployments. In the long run, however, there should be little change in operating costs.

CONGRESSIONAL ACTION TO DATE

As this study goes to press, Congressional action is proceeding on the President's budget request for fiscal years 1988 and 1989. The House and Senate have completed action on a bill authorizing defense appropriations for 1988 and 1989, while the House Committee on Appropriations has issued a bill appropriating funds for 1988. Because budget actions are not completed, they are not reflected here; costs and savings in this study reflect the President's budget proposals.

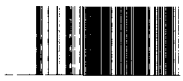
Congressional action will certainly affect the detailed costs of options in this study. Beyond slowing the development of systems, however, actions to date include no major changes in plans for offensive strategic weapons. In fact, in the case of ICBM modernization, the authorization conferees explicitly decided to preserve both the SICBM and Rail MX programs as options for the next Administration. Thus, the issues discussed in this chapter are likely to be options in next year's debate. The table below shows Congressional action to date on selected major weapons systems.

	President's Budget Request	Authorization Conference		House Committee on Appropriations
		Low Tier a/	High Tier	
SICBM	2,233	700	1,500	1,575
Rail MX	591	100	300	250
Trident Submarine	1,194	1,154	1,154	1,124
Trident II Missile				
(Procurement)	1,931	1,931	1,931	1,462
(RDT&E)	1,099	1,049	1,074	1,000

SOURCE: Congressional Budget Office using budget data for fiscal year 1988.

a. The low tier applies if total appropriations for the national defense function (050) equal $289 billion of budget authority or less.

APPENDIXES




APPENDIX A

DESCRIPTION OF THE UNITED STATES TRIAD OF STRATEGIC OFFENSIVE FORCES

For more than two decades, U.S. nuclear forces have consisted of the triad of land-based intercontinental ballistic missiles (ICBMs), long-range bomber and tanker aircraft, and submarine-launched ballistic missiles (SLBMs) on strategic nuclear submarines (SSBNs). The individual components of the triad are described below.

THE ICBM FORCE

The ICBM force probably has the most complete set of desirable operational characteristics. These include accuracy, high alert rates, secure and reliable command and control, targeting flexibility, and ability to retaliate promptly with considerable likelihood of penetrating to a target. The most glaring weakness of silo-based ICBMs, which currently characterizes all U.S. ICBMs, is their vulnerability to a preemptive attack. They cannot be recalled once launched.

Minuteman II. The 450 single-warhead Minuteman IIs were deployed starting in 1965. Their warheads are relatively large but inaccurate.

Minuteman III. These ICBMs are equipped with three multiple independently targetable reentry vehicles (MIRVs). Of 550 Minuteman IIIs, 250 carry the Mk 12 warhead and 300 the higher-yield Mk 12A. All have been improved with more accurate guidance systems. Fifty Minuteman IIIs are being replaced with MX missiles.

The MX. The MX missile is considerably larger than Minuteman, more than tripling the throwweight and doubling the accuracy of its predecessor. One MX can deliver up to 10 Mk 21 warheads. Fifty MX missiles are currently being fielded in existing Minuteman III silos. The Administration has proposed fielding an additional 50 MX in a rail-basing mode beginning in 1991.

The SICBM. Current Administration plans call for deploying 500 new, small ICBMs (SICBMs) beginning in 1992. The SICBM will probably be about half the length of the MX missile and weigh only 20 percent as much. It would carry a single warhead, and have the accuracy needed to destroy hardened targets. These missiles would be deployed in mobile launchers collocated at Minuteman sites in peacetime.

THE BOMBER FORCE

About 30 percent of the bomber force is on continuous alert in peacetime--that is, ready to be launched on its mission within minutes of notification. During times of tension or crisis, most of the bomber force can be put on alert, and dispersed to more bases to increase chances for survivability. Bombers on alert are very likely to survive a preemptive attack, and can be recalled once launched, or can land and be recovered outside the United States. Bombers would take many hours to reach targets over the Soviet Union, however, and in the case of a penetrating bomber carrying short-range weapons, would face heavy Soviet air defenses. Cruise missiles launched from bombers have excellent ability to penetrate air defenses, but are relatively slow-flying.

FB-111A. A medium bomber first introduced in 1969, the FB-111A is expected to retain its strategic mission through the 1980s, and to phase into a tactical role in the early 1990s.

B-52G. Delivered between 1959 and 1961, the B-52Gs have received extensive structural and avionics modifications over the years. Ninety-eight B-52Gs were recently equipped to carry 12 cruise missiles (ALCMs) on external wing pylons. The remaining 69 B-52Gs will retain their nuclear roles until the late 1980s. By 1989, they will become a dedicated conventional/maritime support force. The ALCM-equipped B-52Gs will also carry nuclear bombs and short-range attack missiles until the B-1B becomes available in larger numbers to take over part of the penetrator role. Used thereafter as standoff ALCM carriers, these B-52Gs would probably be retired in the 1990s.

All B-52s have received avionics upgrades like the Offensive Avionics System (OAS) and new radio receivers, and most are receiving updated electronic countermeasures equipment.

B-52H. These bombers were delivered between 1961 and 1962. As of March 1987, about one-quarter of the 96 B-52Hs had been modified to carry ALCMs externally, as have the B-52Gs. These modifications should be complete by fiscal year 1990. A separate program will modify the aircraft to carry up to eight ALCMs internally as well. These aircraft will carry both cruise missiles and short-range weapons into the late 1980s, when they will begin taking on more of a stand-off cruise missile carrier role as new bombers are fielded and as the B-52Hs are modified to carry ALCMs internally.

B-1B. The B-1B will rely on a smaller radar cross section than the B-52s, improved speed and low-altitude capabilities, and sophisticated electronic countermeasures to penetrate Soviet air defenses through the 1990s. It will have cruise missiles added to its weapons mix when the Advanced Technology Bomber is fielded. The first B-1B was delivered in June 1985, and all 100 will be in the inventory by 1988.

Advanced Technology Bomber (ATB). The ATB, or "stealth" bomber, recently named the B-2, incorporates material and design technologies that would make detection by radar and infrared sensors quite difficult. The Administration chose the ATB program as the second part of its two-bomber modernization approach. It will be fielded starting in the early 1990s, with an ultimate force size of 132. Details are classified.

Air-Launched Cruise Missile (ALCM). The ALCM is a small, low-flying, nuclear-armed, unmanned aircraft to be carried by B-52 and B-1B bombers. Launched hundreds of miles from its target, it guides itself by comparing topographical features measured in flight with preprogrammed terrain information. The Administration plans to purchase a total of 3,200 ALCMs of all types, which will provide about 2,880 on-line missiles and a maintenance pipeline. This plan represents a decrease of about 900 deployable missiles from the Administration's 1981 program. The plan includes the substitution of an advanced cruise missile (ACM) currently being procured, that reportedly has longer range and, through "stealthy" technology, even lower radar

detectability than its predecessor. This new ACM would eventually account for somewhat less than half of the total ALCM inventory.

Short-Range Attack Missile (SRAM). Deployed in the early 1970s, these short-range nuclear-armed missiles can be launched from penetrating bombers to suppress in-route air defenses and to attack--from a distance--targets having their own air defenses. Beginning in 1993, a new SRAM--designated SRAM II--will begin replacing its aging predecessor. A new warhead plus increased range and accuracy will give these new missiles greater capabilities, especially against mobile and hardened targets.

THE SEA-BASED FORCES

Submarines at sea--more than two-thirds of the total force in peacetime--are currently the most survivable and enduring of U.S. forces. With the new Trident II (D-5) missile, this force will also have the capability to retaliate against hardened targets for the first time. Maintaining reliable, secure communications in time of war has always been the greatest area of concern and difficulty with respect to the submarine force.

Poseidon Submarines. Twenty-eight of the 31 original Poseidon submarines are still in the force. Twelve of these submarines carry the newer, more accurate, longer-range Trident I (C-4) missile. Currently, the Navy plans to operate its Poseidon submarines into the 1990s, for an average lifetime of about 30 years.

Trident Submarines. The newest addition to the ballistic missile submarine (SSBN) fleet is the Trident submarine. Considerably larger than the Poseidon, it has 24 launch tubes (instead of 16). The first Trident, USS OHIO, made its initial patrol in the fall of 1982. Seven Tridents are now operational, with an eighth in sea trials.

Fifteen of these submarines have been authorized through fiscal year 1988. The Administration projects a procurement rate of one submarine per year. The Navy plans to base the first eight Tridents in Bangor, Washington, and is building a second Trident base at King's Bay, Georgia. The Navy projects an ultimate force size of 20 Trident submarines, although no final determination has been made.

The first eight Trident submarines will be initially fitted with the Trident I (C-4) missile. Generally coincident with their first overhaul periods, they will be converted to carry the larger Trident II (D-5) missile. All Tridents after number eight will have the Trident II missile system installed during construction.

Poseidon (C-3) SLBM. The oldest deployed submarine-launched ballistic missile (SLBM), the 2,500-mile-range Poseidon (C-3) was introduced in 1971. It carries 10 relatively low-yield warheads and is deployed on 16 Poseidon submarines.

Trident I (C-4). Twelve Poseidons carry the longer-range (4,000 miles) Trident I (C-4) missile, introduced in 1979. Each of the first eight Trident SSBNs will carry the C-4 for about their first nine years of service until it is replaced by the Trident II (D-5). The Trident I carries eight warheads.

Trident II (D-5). The D-5 missile--to be deployed starting in 1989--will be significantly larger than its predecessor, the C-4, and will have a greater payload capability (up to 75 percent more than C-4), much better accuracy, and comparable range at maximum load. The Navy is reportedly planning to use a mix of smaller Mk 4 warheads and new Mk 5 warheads in the Trident II force. More of the smaller warheads can be put on each missile, giving better coverage of soft targets. The larger warhead, combined with the accuracy of the new missile--less than 500 feet Circular Error Probable--will give first-time "hard-target" destruction capability to the sea-based missile force. The missiles will reportedly carry no more than 12 Mk 4 or 8 Mk 5 warheads.

APPENDIX B

MEASURES AND METHODS USED IN THIS ANALYSIS

While the measure of deterrence is more than numerical, judgments about the state of deterrence cannot be made without a picture of the underlying numerical balance between the U.S. and Soviet strategic forces and trends in that balance. In assessing the capabilities of strategic forces, this study used measures of effectiveness that need to be precisely defined. It also made assumptions about force postures--or scenarios--that can greatly affect the analysis.

PRE-ATTACK MEASURES OF BALANCE

Some measures consider the numbers of weapons available before either side mounts an attack. These numbers are useful for measuring the relative parity and general stability of the U.S. and Soviet force balance. This analysis uses three main pre-attack measures of effectiveness.

Total Warheads. This is a measure of general capability against a potential set of targets. This measure includes warheads on all three types of systems of the U.S. nuclear triad: strategic bombers and land-based and submarine-based missiles.

Hard-Target Warheads. These represent a subset of total warheads. For purposes of this study, hard-target warheads include Class 1 and Class 2 warheads in a schema developed by CBO in a recent study.1/ These warheads have a high probability of destroying targets--such as

1. Class 1 warheads have a 70 percent probability of destroying a 5,000 psi target. Of the ballistic missile warheads, only the U.S. Mark 21 warheads on the MX ICBM and the planned small ICBM, and the Mark 5 warhead on the forthcoming Trident II SLBM would meet that standard. Class 2 warheads have a 70 percent probability of destroying a 2,000 psi target. The U.S.

(continued)

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ICBM silos, deep underground command and control centers, and leadership bunkers--that are highly hardened to withstand nearby nuclear detonations. Because these warheads can attack key military targets, they are analyzed separately.

Hard-target warheads on ballistic missiles--as opposed to those on bombers--are often distinguished as "prompt," since they would take only minutes to reach their targets and could be used in an immediate counterstrike on Soviet targets. Bomber-carried weapons would take hours to reach their targets. In a "bolt-out-of-the-blue" attack, some submarine-launched missiles might also be delayed because of activities, such as training and exercises, in which the submarine was engaged.

Another subset of hard-target warheads includes those that are deployed in fixed locations--namely, land-based intercontinental ballistic missiles (ICBMs) in silos. These systems are increasingly vulnerable to attack by more accurate weapons and, in the case of a multiple-warhead ICBM, they provide a favorable ratio of attacking warheads to warheads destroyed. Because this vulnerability could prompt their early use in a crisis, these systems often figure heavily in debates concerning stability of forces in a crisis.

Throwweight. This is a measure of the payload capacity of a missile. Many analysts consider this measure important because excess payload capacity can indicate ability to increase--perhaps surreptitiously--the size and/or number of warheads on a missile. Others consider the measure overemphasized. They cite the difficulty of making such

1. (continued)
Mark 12A warheads on Minuteman III missiles and Soviet warheads on the SS-18 meet that standard. In this study, the SS-25 is considered a Class 2 weapon, since its reported throwweight would allow it to carry a large warhead. However, this estimate is speculative. Class 3 warheads have a 70 percent probability of destroying a 500 psi target, which is representative of a group of medium-hard targets that include munition bunkers, leadership bunkers, command and control centers, and older Soviet ICBM silos. The U.S. Mark 12 warhead on some Minuteman III missiles and the Mark 4 warhead on forthcoming Trident II missiles meet that standard, as do Soviet warheads on the SS-17, SS-19, and, reportedly, the recently deployed SS-24. Of bomber-carried weapons, bombs, cruise missiles, and the forthcoming short-range attack missile (SRAM II) fall in the range of Class 1 and 2 war- heads. For additional details on hard-target warhead capability and this classification scheme, see *Trident II Missiles: Capability, Costs, and Alternatives*, pp. 8-12.

changes surreptitiously and consider the leverage of such increases minor, except perhaps when the overall levels of missile forces are very small. Excess throwweight also allows for a greater number of aids or decoys, which are useful for penetrating or overwhelming ballistic missile defenses.

POST-ATTACK MEASURES OF BALANCE

Because U.S. policy for deterrence calls for strategic nuclear forces capable of surviving an attack and retaliating, measures of post-attack or retaliatory capability are important. In addition, post-attack measures can illustrate the marginal contribution that continuing modernization programs make to U.S. capability. For instance, 500 small ICBM (SICBM) warheads that may be deployed in the 1990s would make only a small contribution to overall pre-attack measures of warheads or even hard-target warheads. Since these warheads will presumably be able to survive a Soviet attack, they make a larger contribution to U.S. retaliatory capability. Also, post-attack measures can indicate the options available to the United States after receiving a Soviet attack.

Post-attack and retaliatory measures used in this analysis are similar in category to pre-attack measures: total warheads, hard-target warheads, and throwweight. But they incorporate the results of an attack by the Soviet Union against U.S. strategic forces (including ICBMs, bomber bases, and submarine posts).

Post-attack measures must be described by the "scenario" accompanying a Soviet attack. An attack without advance warning (called a "bolt-out-of-the-blue" attack) is considered by many to be the greater challenge to U.S. capabilities. While silo-based ICBMs are always on alert, only about a third of the bomber force is on alert in peacetime--that is, poised to react promptly to escape a Soviet attack. On a day-to-day basis, more than two-thirds of the submarine force is at sea, and not vulnerable to attack. However, only a portion of those at sea are ready to respond quickly to a launch order. Given the large, proliferated arsenals of the superpowers, however, an attack without warning is also widely considered to be the most unlikely. If the structure or balance of strategic forces were such that an opponent felt a sur-

prise attack would be a decisive blow, then the danger and probability of this type of attack would be much greater.

An attack preceded by tensions or conflict elsewhere--such as Western Europe, the Middle East, or Southwest Asia--is considered most probable. In this scenario, escalation to nuclear war could arise out of a desire to intimidate or demonstrate resolve to a superpower opponent. While ultimately such escalation may result in an irrational level of damage--one far exceeding the original objective--it would not have begun that way.2/ Under these circumstances, more U.S. forces could survive even in the face of a larger attacking Soviet arsenal, since all systems except those in maintenance and overhaul could be brought to a war footing to escape destruction.

One other assumption is important in this analysis. In the general case, ICBMs in silos are assumed to "ride out" an attack since they cannot be dispersed. U.S. policy, however, neither assumes nor precludes launching these missiles upon confirmation that a Soviet attack was under way. In fact, the Soviet Union cannot be sure that the United States would ride out an attack on its ICBMs, especially in a case where a potential attack was anticipated.

METHODS USED FOR POST-ATTACK MEASURES

To assess the survivability of the silo-based ICBM force, this study used a simple allocation model that assigns the most capable of the available Soviet warheads to the most "valuable" U.S. missile silos, with value weighted by the number of warheads carried by the missile in that silo. Damage calculations are based on public estimates of Soviet missile characteristics, such as warhead yield and accuracy, and calculations of nuclear effects developed by the Defense Nuclear Agency.

The general case in the text--a Soviet attack with strategic warning--assumes that the Soviets would not conduct a barrage

2. While this scenario is describing escalation by the original aggressor, it is similar to the declared U.S. policy of "flexible response" in Europe where the U.S. would escalate to raise the price of aggression high enough to cause the Soviets to back down.

attack against dispersed mobile ICBM missiles because of the tremendous resources required. In the case of a surprise attack where the Soviets are assumed to attack these missiles, the damage algorithm, on which the expected destruction is based, uses what is known as a "cookie-cutter" or ratio-of-areas calculation. The calculation considers the relationship of the area (or line, in the case of Rail MX) of uncertainty within which the targets are dispersed, and the lethal area of the attacking missiles.

Submarines at sea are largely invulnerable today, and there are no indications that status will soon change. All submarines in port are assumed destroyed.

Because of their quick reaction time, the only significant threat to the initial survivability of bombers on alert in a Soviet attack are Soviet submarines patrolling off the U.S. coast. (Soviet air defenses are a threat to penetrating bombers on their retaliatory mission.) Barraging bombers in airspace poses an even greater demand on Soviet resources than barraging land-based mobile missiles. An earlier analysis by CBO indicates that, even with a barrage attack, the survivability of bombers on alert is extremely high. The greatest degradation occurs in the case of the Soviets using depressed trajectories for their SLBMs to shorten their time of flight--a capability they have not tested extensively if at all. Furthermore, Soviet practice has been to keep their newer submarines closer to their territory, probably lessening the threat of a barrage attack over time. In this study, it is assumed that the Soviets do not barrage airborne bombers. A description of the bomber survivability model and general results appear in the 1983 CBO study *Modernizing U.S. Strategic Offensive Forces: The Administration's Program and Alternatives*. Bombers not on alert are not expected to survive.

Limitations of the Measures

When using numbers of warheads to assess the capabilities of forces surviving an attack, several limitations should be kept in mind.

- The measures used in this study are most useful for observing trends in force survivability and retaliatory capability. The study does not examine detailed operational con-

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siderations that would affect targeting and force survival in actual war plans. Also, projections of force structures and capabilities inevitably rely on many uncertain assumptions.

- As is the case with most other analyses of this type, this study assumes that the command and control system would be able to direct U.S. forces to retaliate in the desired manner after a Soviet first strike. If command and control were not able to survive and respond, most of the other analysis would be moot. The Administration has made a high priority of improving these capabilities.

- This analysis assumes that none of the U.S. strategic submarines at sea is destroyed in an attack. Most analysts would agree with this assumption for the 1980s, and Administration representatives have indicated that it is a reasonable assumption through the 1990s. While the Soviets have reportedly made great strides in rendering their own submarines less detectable, finding U.S. submarines should remain a difficult problem for them.